MODEL ANSWER
A2 PHYSICS
MAGNETIC FIELD & EM INDUCTION

21 JAN 2008 PHY5

4. (a) (i) The magnetic field is uniform at the length between 18 cm to 82 cm of the axis of the solenoid

(ii) The magnitude of the current in the solenoid can be determined by the expression

$$\mathbf{B = \mu_0 n I}$$

Where **B = magnetic flux density**
μ_0 = permeability of free space
n = number of turns per unit length
I = current

Hence, $\mathbf{I = B / [\mu_0 n]}$
$\mathbf{= 6.0 \times 10^{-4} / [4\pi \times 10^{-7}][300/\{0.82-0.18\}]}$
$\mathbf{= \underline{1.27\ A}}$

(iii) The factor that determines the direction of the magnetic field within a solenoid is the direction in which turns are wound.
OR
The factor that determines the direction of the magnetic field within a solenoid is the direction of current in the solenoid.

5 (a) (i) At position 1, as the side QR cuts through the uniform magnetic field of flux density and brings about a change of magnetic flux. Based of Faraday's Law, e.m.f is induced and current flow from R to Q, passing through the ammeter from Q to P.

At position 2, as the square rigid metal frame is PQRS is moving across the uniform magnetic field of flux density with uniform velocity, there is no change of flux, therefore no e.m.f Is induced and therefore no current.

At position 3, as the side QR leaves the uniform magnetic field of flux density, there is a change of magnetic flux. Based on Faraday's Law, an e.m.f is induced and current flow from S to P, passing through the ammeter from P to Q.

(ii) E.m.f induced, **E = Blv**
E = IR
Therefore **Blv = IR**
I = Blv/R
$\mathbf{= [2.0 \times 10^{-2} \times 0.12 \times 0.05] / [2.0]}$
$\mathbf{= 6.0 \times 10^{-5}\ A}$
$\mathbf{= \underline{60\ \mu A}}$

(b) As the frame moves through position 1, the magnitude of current is increasing because the rate of change of flux is increasing due to acceleration of the frame through the uniform magnetic field

of flux density. The increase of the current magnitude at position 3 is larger than the increased of current magnitude at position 1. As the velocity of the frame increases from position 1 to position 3, the rate of flux change is greater at position 3, therefore based on Faraday's Law, larger e.m.f is induced. Current for position 2 is zero because net rate of flux cutting is zero. Electromotive forces induced in each PS and QR are equal but directionally oppose each other, therefore no net current flow in the frame.

PREPARED BY MR.DERYK NG
UCSI UNIVERSITY
A LEVEL ACADEMY